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THE CALIFORNIA EARTHQUAKE OF APRIL 18, 1906

REPORT

OF THE

California, STATE EARTHQUAKE INVESTIGATION COMMISSION

IN TWO VOLUMES AND ATLAS

VOLUME I, PART II



WASHINGTON, D. C.

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1908

COMPARISON WITH OTHER SEVERE EARTHQUAKES IN THE SAME REGION.

THE EARTHQUAKE OF 1868.

The earthquake of October 21, 1868, was most severely felt in the region about San Francisco Bay, particularly on the east side in the vicinity of Haywards. The time of its occurrence is variously stated from 7^h 47^m to 7^h 54^m A. M. It gave rise to disasters in the city of San Francisco, and some people recalling the event vividly are of the opinion that the shock was as severe as that of April 18, 1906. Early in the investigation of the latter earthquake, it became apparent that the relationship of the two earthquakes would be an essential part of the inquiry. Shortly after the earthquake of 1868 a committee of scientific men undertook the collection of data concerning the effects of the shock, but their report was never published nor can any trace of it be found, altho some of the members of the committee are still living. It is stated that the report was suppressed by the authorities, thru the fear that its publication would damage the reputation of the city. Our knowledge of that earthquake is therefore not very full, and is contained chiefly in the newspaper reports of that day. A summary of this data is given in Holden's Catalogue of Earthquakes,¹ and by Griesbach.²

With the object of supplementing the facts regarding the earthquake of 1868 recorded by Holden, for the purpose of comparing it with that of 1906, an inquiry was started and intrusted to Mr. A. A. Bullock. This gentleman has reviewed the periodicals of the time, and has interviewed many people who experienced the shock. He has also examined the region of maximum intensity, and has had, on several of his trips, the guidance of old residents. In response to a request by the Commission, several people have written an account of their experiences at the time of the earthquake of 1868. In this way a considerable body of valuable information has been gotten together, which supplements to an important degree the extant accounts of that earthquake.

THE FAULT-TRACE.

It appears from Mr. Bullock's inquiries that the earthquake of 1868 was due to an earth-movement along the base of the hills which overlook San Francisco Bay on the east, and which are often referred to, particularly farther north, as the Berkeley Hills. These hills present a remarkably even, straight front, and without doubt represent a degraded fault-scarp. Along the base of this scarp a crack opened on the morning of October 21, 1868. This crack is regarded as the trace of the fault which caused the earthquake. Its position has been determined at intervals along a nearly straight line from the vicinity of Mills College, east of Oakland, to the vicinity of Warm Springs near the Santa Clara County line; but the evidence of its existence to the northward of San Leandro is not very satisfactory. The county was then unsettled, and the information consisted of reports of cow-boys riding the range. From San Leandro southeastward, however, the evidence is full and conclusive. The general trend of the fault is north-west-southeast; or, to be more exact, N. 37° W., a bearing almost the same as that of

¹ Smithsonian Misc. Coll., vol. xxxvii, 1898.

² Mitt. d. k. k. Geograph. Gesellsch. in Wien, Band xii, 1869, pp. 223-231.



A. Flour mill, Haywards. Wrecked by earthquake of 1868.



B. Edmonson's warehouse, Haywards. Wrecked by earthquake of 1868.



C. Flour mill and warehouse, Haywards. Wrecked by earthquake of 1868.



D. Pierce's house, Haywards. Earthquake of 1868.



E. Haywards. Wreck of buildings by earthquake of 1868.



F. Court-house, San Leandro. Wrecked by earthquake of 1868.

From photographs preserved by Mr. H. Bendel.



Effects of the earthquake of 1868 in San Francisco. From photographs preserved by Mr. H. Bendel.

the fault-trace of 1906 along the San Andreas Rift. The position of this fault-trace is shown on map 4. While in general it lies along the base of the old degraded scarp, it is still, for the most part, within the hill-slopes and not in the alluvium which extends from the base of the hills. In some places where it crossed the lower ground, the crack showed faulting or displacement of 8 or 10 inches, but from the accounts given it is not clear in what direction the faulting took place. The statements indicate a slight down-throw on the southwest side. In other places a displacement of 3 feet is said to have been observed. In places the crack along the fault-trace opened to a very considerable depth with a width of 10 or 12 inches, and remained open until filled with falling earth. On the higher ground of the hill-slopes no open crack was observed; there was merely the trace of the rupture in the sod. This fault-trace could be followed at intervals for 20 miles southeast from San Leandro, and it had a straight course without regard to the contour of the hills. In some places it was quite at the bottom of a hillside, while at other places it was high on the slope; and on at least one low hill it past near the top thru a saddle-like depression. Springs are common along the base of the hills, and the fault-trace was above the springs. According to the testimony of old residents the flow was not affected by the earth-movement.¹ In the hills to the northeast of the fault-trace, however, new springs were started and old ones revived, altho some few ceased flowing.

That the crack extended down into the bedrock is testified to by many who observed closely. Three men reported that they tried to sound the bottom of the crack, but were unable to do so. In the vicinity of Haywards it is reported that there were two branch cracks from the main one, trending off into the hills. Water and sand were ejected from the crack in one place.

Between Decoto and Niles the crack left the base of the hill front, and deviating slightly from its general trend thus far, crossed the plain of the alluvial fan of Alameda Creek at the mouth of Niles Canyon to the foot-hills at the town of Irvington. For the greater part of this distance, it appeared as an open crack. It past thru a lagoon about 0.5 mile in length, following closely the longer axis of the depression, and the water of the lagoon was drained out, apparently into the crack. At Irvington the crack became coincident with the very straight and even ancient fault-scarp of the foot-hills southeast of that town. This ancient scarp has a strike of N. 38° W. Beyond this it was not observed farther than Aqua Caliente Creek.

Immediately to the east of Mission San Jose, entirely within the hills, another crack opened with a strike of N. 18° to 20° W., which, converging upon the crack thus far traced, extended south as far as the county line.

The greatest intensity of the earthquake was along the crack and in its vicinity. On the projection of this line southward into Santa Clara County, the intensity diminished steadily as far as Morgan Hill, where it again rose. At Gilroy, Hollister, and San Juan, according to reports, the intensity was sufficient to throw down a few chimneys and to crack some brick and adobe buildings.

The greatest damage was done at Haywards, where nearly every house was thrown off its foundations; while at San Leandro the shock was less severe. (See plate 144.) A house near old Blair Park, in the present Piedmont district of Oakland, was badly damaged. The only other town of that date in close proximity to the fault-trace was Mission San Jose, which lies in the hills a few hundred yards west of it. In this town were several adobe buildings, one of which, a church, was wrecked. Many chimneys were thrown, but the general effect was much less severe than at Haywards.

¹ The gentlemen who chiefly aided Mr. Bullock in tracing out this crack are Messrs. W. Smith, S. Huff, and McCarthy, of San Leandro; Messrs. O. Hill, F. F. Allen, F. Wrede, and H. V. Monsen of Haywards; Mr. Decoto, of Decoto; and Mr. W. Berry, of Niles.

In general, the direction of throw of objects was north or south. From several tanks the water slopt north and south. Nearly all the chimneys reported were thrown either north or south. Several frame houses were thrown south. One of these, 0.5 mile south of the line of the fault, was thrown 4 feet and another on the line was violently thrown 6 feet.

Several people report that rumblings preceded the shock, coming apparently from the south or southwest. Others saw a wave-like motion set up in the surface of the ground approaching from the south or southwest.

THE EFFECT OF THE EARTHQUAKE IN SAN FRANCISCO.

At San Francisco and nearby points the earthquake lasted for about 42 seconds. It was in general north and south.¹ A second shock followed the first at 9^h 23^m A. M., and lasted for 5 seconds, with the same direction as the first. Until about 12^h 15^m P. M., light shocks continued to be felt about every 30 minutes; and inside of the 24 hours immediately following the initial shock, 12 minor shocks were felt. The first indication of the approach of the earthquake was a slight rumbling sound, coming apparently from the direction of the ocean. The sound was heard very distinctly in the lower part of the city, but the residents on the hills do not appear to have heard it. (*San Francisco Times*, Oct. 21.) The shock commenced in the form of slow, horizontal movements. The oscillations continued from 10 to 15 seconds, growing more rapid and more violent for 6 or 7 seconds, then partially ceasing for 3 or 4 seconds, then increasing in force and rapidity for 4 or 5 seconds, then suddenly ceasing. (*Alta California*, Oct. 22, 1868.)

There were no abnormal barometrical changes at the time of the earthquake. No chronometer in Mr. Tennent's office was disturbed or showed any change of rate. The pendulum clock in his office was not stopt. A transit instrument erected on Russian Hill, belonging to him, was not disturbed in the slightest degree. Two magnets, one in his office and one in charge of a friend, showed no loss of magnetic power. One was loaded to its full extent, and the slightest loss of power would have permitted the weight to fall. (*Bulletin*, Oct. 22, 1868.)

The portion of the city which suffered most was that part of the business district, embracing about 200 acres, built on "made ground"; that is, the ground made by filling in the cove of Yerba Buena. (See plates 145 and 146.) The bottom of this cove was a soft mud varying from 10 to 80 feet in depth, and the material used to fill it was largely "dump" refuse, much of which is organic and hence perishable. Many of the buildings of that period were built flat on this filled mud, without piling, and before the land had had time to become firm. On this made land there was a very evident belt of maximum damage several hundred feet wide and running about northwest and southeast, commencing near the custom-house and ending at the Folsom Street wharf. One account of this belt goes so far as to trace 8 or 10 distinct lines of maximum disturbance, practically every building on these lines being more or less damaged, while none outside of these lines was seriously injured.

In many places the made land settled. At the junction of Market and Front Streets, the ground sank for a foot or two, and there was evidence that the tide had risen in the adjoining lot at the same time, for a pond of water collected and remained until low tide. On Pine Street, near Battery, the cobbles on the south side of the street sank away from the curbstones to the depth of 1 foot in some places; and the asphalt sidewalk on the north side was twisted and torn out of all shape, and its connection with the curb-stone severed. (*Alta California*, Oct. 22, 1868.)

¹ Thos. Tennent, agent U. S. Coast Survey, in *Alta California*, on Oct. 22, 1868, reports it as lasting 46 seconds and as being from southeast to northwest (nearly) in direction.

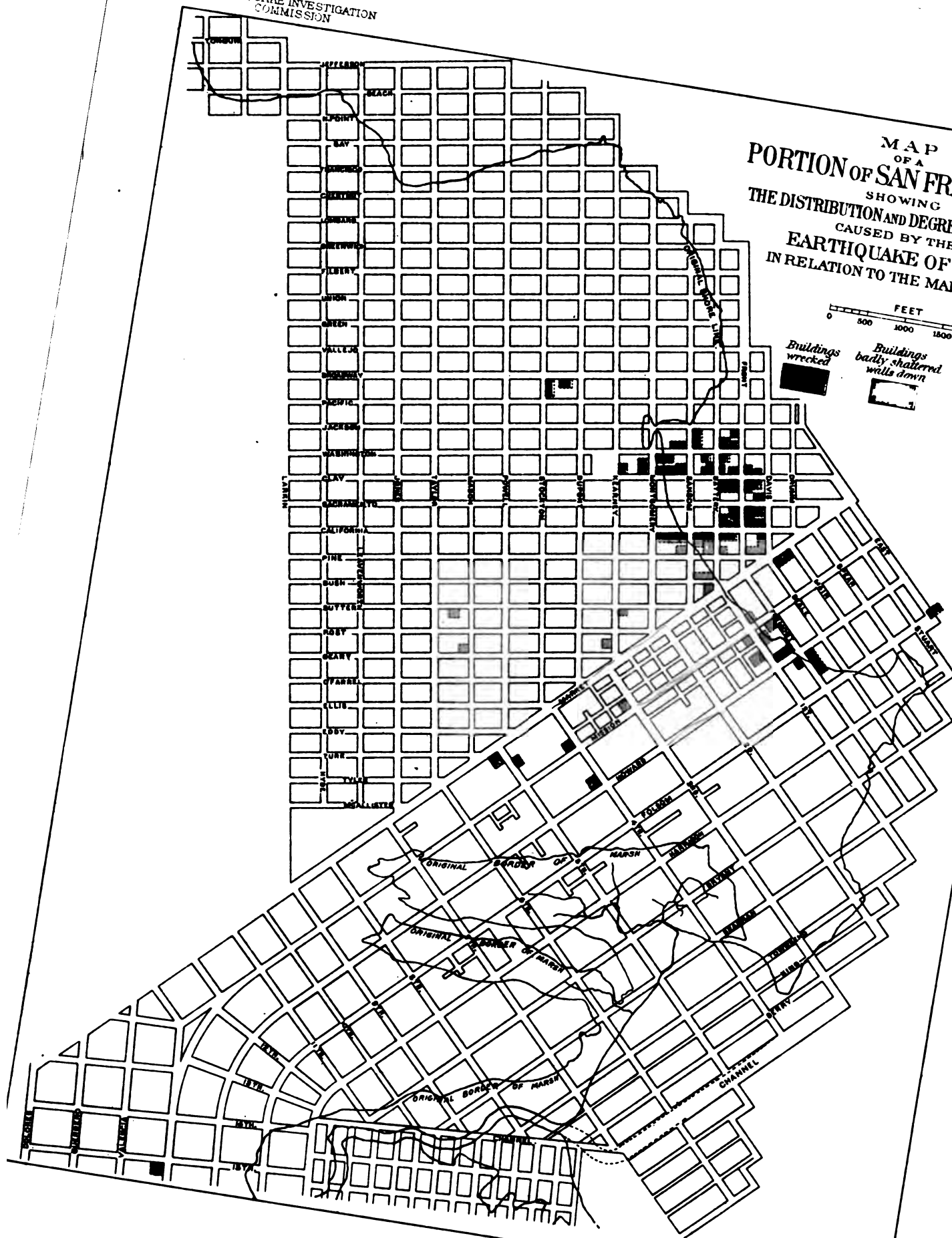
MAP
OF A
PORTION OF SAN FRANCISCO
SHOWING
THE DISTRIBUTION AND DEGREE OF DAMAGE
CAUSED BY THE
EARTHQUAKE OF 1868
IN RELATION TO THE MADE LAND

FEET
0 500 1000 1500 2000

Buildings
wrecked

Buildings
badly shattered
walls down

Walls of
buildings
cracked



At the corner of First and Market Streets, the ground opened in a fissure several inches wide. At other places the ground opened and water was forced above the surface. (*San Francisco Bulletin*, Oct. 21, 1868.) At Fremont and Mission Streets the ground opened in many places. (*Alta California*, Oct. 22, 1868.) The general course of damage in the city was along the irregular line of the "made land," or low alluvial soil, where it met the hard or rocky base beneath it. Along the line of the old shore of Yerba Buena Cove, we found the damage to brick buildings much the largest. (George Davidson.) The custom-house, at the corner of Sansome and Clay Streets, was hurled south, by what seemed to be an undulating motion, and plaster fell. (*Bulletin*, Oct. 22, 1868.)

The outstanding portico on the east side of the custom-house was so badly shattered that it had to be removed; the main building stood fairly well, but one of the chimneys was broken across at the roof-line and turned thru an angle of over 45°. (George Davidson.)

The ground floor and the foundation of the old Merchants' Exchange appeared to have taken a different motion from the upper portion. The arch over the main corridor appeared to have been crushed. Just underneath the center, the matting was raised 2 inches. The corresponding arch at the south end of the corridor was also damaged, and there was a similar protuberance under the matting beneath it. Smaller arches at right angles to the main arches described were crushed in similar fashion. The north and south walls of the building, at the second floor, over the main arches, opened in large cracks. (*Bulletin*, Oct. 22, 1868.)

A 3-story brick structure on the corner of Market and Battery Streets, in an unfinished condition, was completely thrown down. Several different reports state, however, that it was very poorly constructed. In the Union Foundry, on First Street at the corner of Market Street, most of the machinery was displaced. (*San Francisco Bulletin*, Oct. 21, 1868.)

The floor of the Pacific foundry was raised about 2 feet in places. The center of Mission Street (opposite Fremont Street) exposed an opening from 8 to 10 inches wide; and openings of the ground were also plainly to be seen on Fremont Street, in the same vicinity. (*San Francisco Bulletin*, Oct. 21, 1868.)

Outside of the immediate district described above, damage to the rest of the city was very meager. It will be noticed in the following notes, and by a consultation of the map of San Francisco, plate 146, that the region of greatest agitation was confined to the low portions of the city, or the vicinity of some old creek bed or swamp.

The flat between Howard Street and Mission Bay was more severely shaken than Russian and Telegraph Hills; but the damage, save to chimneys and plaster, was slight. The only serious injury on Kearney Street was done to a building on the east side of the street. The building was an old one. At the corner of Fifth and Market Streets a fire-wall was thrown down. At the corner of Fourth and Bryant Streets, walls were cracked and damaged; Fourth Street near Bryant opened in places and at the crossing of Harrison and Fourth the railroad track settled about 8 inches, the planks between the rails rising about 10 inches. The Lincoln School-house (east side of Fifth Street near Market Street) was badly damaged, most of the chimneys being broken but none thrown down. The large statue of Lincoln in front of the building was ruined, but was not thrown off its pedestal. (*San Francisco Bulletin*, Oct. 21, 1868.)

The large chimney of the sugar refinery on Eighth Street fell in, crushing thru the ceilings. (Letter to *New York Times*, Oct. 21, 1868.)

A drug store at the corner of Fifth and Folsom Streets had its entire stock destroyed by falling. The chimneys of the Mission Street public school (west side of Mission Street between 15th and 16th Streets) toppled off some bricks. (*Alta California*, Oct. 21, 1868.)

A part of the brick walls of the new Calvary Church (Geary and Powell Streets) fell. A small crevice opened, as in 1865, on Howard Street beyond Sixth Street. No damage was sustained by the dry-dock at Hunter's Point. On the beach at the foot of Webster Street, below high-water mark, a fissure opened, extending lengthwise with the water. The stream of a sewer running from the Laguna to the foot of Webster Street into the bay, hitherto clear, immediately turned inky black. (*Alta California*, Oct. 22, 1868.)

The sugar refinery at North Point, a 7-story brick structure, surmounted by a tall brick chimney, was injured to the extent of losing 6 or 7 feet of its 100-foot chimney. A large fissure was made in the high bank near Fort Point and the shock was felt severely at the Fort. (*San Francisco Times*, Oct. 22, 1868.)

At the Cliff House nothing unusual took place, with the exception of a decided commotion in the ocean and an impetus given to the every-day wave which sent it well inland, say 15 or 20 feet above the usual mark. The shock, however, did no damage, not even upsetting any of the glassware in the bar. (*Alta California*, Oct. 22, 1868.)

Upon Russian and Telegraph Hills the shock was not very damaging. In some houses on the latter ornaments were not displaced from the mantel and the inmates did not come to the doors. In others, books and ornaments fell down and marble mantels were started from their places. The oscillations on Russian Hill were more severely felt. There was a pretty general stopping of clocks, some cracking of plaster, and throwing down of light articles. (*San Francisco Bulletin*, Oct. 21, 1868.)

A pail of water, two-thirds full, on the ground at the summit of Russian Hill, sloped over both sides. (*Alta California*, Oct. 22, 1868.)

The colored Masonic Hall, Stockton Street between Pacific and Broadway, a 2-story brick structure, was badly wrecked. (*San Francisco Times*, Oct. 22, 1868.)

From the meagerness of reports it is certain that no great loss was occasioned by the parting of water mains. The *Bulletin* for October 21 reports that the water at the Mission was shut off by the pipe being disconnected. In several parts of the city the water-pipes broke underground and caused some loss of water, but the water company soon had all repairs made. No fires are reported in the upper Mission district during the 24 hours following the earthquake. At Laguna Honda (a natural reservoir and the chief source of water supply, 2.5 miles west of Valencia and Market Streets) the water was violently agitated and the waves met in the center, throwing up a large jet several feet into the air. (*Alta California*, Oct. 22, 1868.)

The first alarm of fire was given shortly after 8 o'clock from Box No. 26 (northeast corner of Clay and Battery Streets). The fire was in Wellman and Peck's grocery (Front and Clay Streets) and was caused by matches. The chief damage was caused by water.

During the night following the earthquake, three fires occurred in the wholesale district, but there was no lack of water and all were quickly extinguished.

In the Fire Commissioner's report in the Municipal Records of San Francisco for 1868-1869, the following losses by fire are recorded: September, 1868, \$24,229; October, 1868, \$133,564.46; November, 1868, \$19,920; December, 1868, \$82,019.

The force of the shock was distinctly felt on the bay and as far as 15 miles west of the heads, but no great agitation of the water is reported. The tide-gage at one of the Government stations indicated no unusual rising of the tide. (*San Francisco Times*, Oct. 22, 1868.)

There was no tidal wave accompanying the earthquake. The passengers on a ferry steamer (off Angel Island) felt the shock and supposed for the time that they were aground. Many other boats reported the same experience. Two boatmen in a Whitehall boat off Fort Point report a heavy rumbling sound coming from the water. Their boat was shaken and whirled rapidly around (before the rollers reached them) and shortly they met 3 heavy rollers coming from the northwest on a calm sea. (*Alta Cali-*

foria, Oct. 22, 1868.) The shock of the earthquake was distinctly felt at sea near San Francisco. Captain Tobey, of the ship *Pactolus*, reported being at anchor in deep water about 15 miles west of the Heads when the shock took place. At first it seemed as if the vessel were passing over a coral shoal and striking quite heavily. The noise and motion made it seem as if the ship were dragging, with her chains also slipping out. (*San Francisco Bulletin*, Oct. 22, 1868.) The ship *Cesarewitz* felt the shock nearly out at the Farallones; the brig *Orient*, bound in, 8 miles out, experienced the shock heavily. Pilot Murphy, on a transport bound out, reported that the bark seemed to have struck bottom, her progress being impeded; and the ship, especially the yards and masts, trembled violently. (*San Francisco Times*, Oct. 22, 1868.)

The total list of casualties due directly to the earthquake numbered 5, and about 25 more occurred from secondary causes. The total loss of property was variously stated from \$300,000 to \$5,000,000. However, a careful estimate of damages made a day or two after the disaster, placed it at about \$350,000. (*San Francisco Bulletin*, Oct. 23, 1868.)

THE DISTRIBUTION OF INTENSITY THRUOUT THE STATE.

Healdsburg. — A good shaking. Heaviest shock ever felt. (*Democratic Standard*, Oct. 24, 1868.) Lasted about 10 seconds. Vibrations north and south. Clocks stopt. (*Alta California*, Oct. 22, 1868.)

Guerneville. — The earthquake was of great severity. It frightened my horse and he started to run away; but a large tree which had been cut nearly thru by choppers, and which they felled a few moments after the shock, was not overthrown by the shock. (I. E. Thayer.)

Santa Rosa. — Severest shock yet felt. Lasted 10 seconds. Nearly all brick buildings in town more or less injured. Many chimneys down. (*Alta California*, Oct. 22, 1868.)

Violent and somewhat protracted earthquake. Vibrations at first from west to east, but suddenly changed from south to north, and continued about a minute. Damage to property considerable. Several brick buildings cracked. At Windsor it was lighter than in Santa Rosa, and farther north still lighter. At Sonoma, Sebastopol, Bodega, and elsewhere, the shock was severe but little damage was done. (*Santa Rosa Democrat*, Oct. 26, 1868.)

Petaluma. — Vibration north to south, 10 seconds in duration. Several brick buildings injured and many chimneys. (*Alta California*, Oct. 22, 1868.) Oscillations from east to west; 3 distinct shocks lasting in all 10 to 15 seconds. (*Petaluma Argus*.)

San Rafael. — Terrible shock. Vibrations southeast to northwest, for fully a minute. (*Alta California*, Oct. 22, 1868.)

Napa. — Violent shock in northeast direction for 30 seconds, accompanied by low rumbling sound. Some slight damage. (*Alta California*, Oct. 22, 1868.)

Most severe shock ever felt. Lasted 40 seconds. No serious damage to buildings. Five miles west of Napa a number of trees were overthrown. (*Napa Reporter*.)

Vallejo. — Earthquake severe. Many chimneys down. (*Alta California*, Oct. 22, 1868.) Heaviest shocks ever felt in Vallejo. One chimney and some plaster down. Dishes thrown from shelves. Bay smooth. (*Vallejo Recorder*.)

Mare Island. — Chimneys were thrown, and some buildings were considerably shaken. Shock accompanied by rumbling sound.

Chico. — A perceptible moving of the earth. Lamps and dishes rattled. (*Chico Courant*, Oct. 23, 1868.)

Colusa. — Slight shock. Not over a dozen people noticed it. (*Colusa Sun*.)

Marysville. — Shock very light; noticed by a few only. (*Alta California*.)

Sacramento. — Pretty heavy shock from southeast to northwest. Plaster cracked.

Lasted 20 to 30 seconds. Water in the river receded, shoaling vessels, and then rose with a rush. (*Sacramento Union*.)

Knight's Landing. — "I was running a flour-mill at Knight's Landing in 1868. While the shock was not unusually severe at that place, it did some damage. The gable end of the mill warehouse was thrown down, not by the vibration of the quake, but by a pile of wheat being thrown down against it and forcing the end of the building out. I was out in a pasture at the time, pumping water for stock, and noting the water sloshing from one end of the trough to the other, I wondered as to the cause, as I had not felt the shock on account of the motion of my body in working the pump. On looking up I noticed the trees swaying back and forth, with no wind, and I knew it must be an earthquake. There was some little loss in the town in the way of broken crockery, chimneys, etc. The heaviest shock was along the edge of the valley near the Coast Ranges. In this county it was heaviest at Winters, where it demolisht John Wolf-skill's house, a stone building, and did considerable other damage." (E. H. Eastham.)

Woodland. — Two severe shocks, from southeast to northwest, lasting a minute. (*Alta California*, Oct. 22, 1868.)

Suisun. — Severe shock, north and south. Slight damage. A few brick buildings cracked. (*Solano Sentinel*, Oct. 22, 1868.)

Solano. — Severest shock ever felt. Sudden upheaval, attended and followed for nearly a minute by a swaying in a north and south direction. No damage except cracks in walls. (*Sacramento Daily Union*, Oct. 24, 1868.)

Martinez. — Some buildings damaged by cracks. Waters in front of town caused to dance. Fish rose to surface. (*Martinez Gazette*.) Court-house wrecked. (Holden.)

Walnut Springs. — Heaviest shock ever felt. Goods in store thrown from shelves. (*Alta California*, Oct. 22, 1868.)

Antioch. — Severe shock from southwest to northeast for 30 seconds. Several fissures formed in the ground. (*Sacramento Daily Union*, Oct. 23, 1868.)

Benecia. — At the repairing works of the Pacific Mail Steamship Company, an iron shaft of one of the side-wheel steamers was lying on the ground in a north-south direction. The earth moved from under it 9 inches, lengthwise, but in what direction is not recorded. (George Davidson.)

Stockton. — "I was then 13 years old. With a younger brother and a third boy I had, on the morning of October 21, 1868, gone to the edge of the tule marsh about 2 miles southwest of Stockton, to shoot ducks. The morning flight of birds was over, and we were returning home. My brother had his gun at the shoulder and was aiming at a meadow-lark when the earth movement commenced. The lark flew up without apparent cause, the gun moved up and down slightly, and I at once had a feeling that something unusual was happening. Within a few seconds the water-fowl, hidden from us by the tule but in countless numbers, rose with a noise like rolling thunder and took flight toward the west; while 0.5 mile to the east a small band of cattle, with heads down and tails in the air, were racing across the country. By this time the earthquake was probably at its maximum, and, looking east, I could distinctly see the ground's surface in wave-motion, the waves apparently moving across the line of vision. During the time this motion continued, it was not perceptible as a vibration to the sense of feeling. All three of us admitted, however, that the earth felt insecure under foot. We could detect no effect on the water surface of the swamp. Stockton escaped with only here and there a cracked brick wall." (C. E. Grunsky.)

Most severe shock ever felt. Vibration from northwest to southeast. West of Lodi and Woodbridge, shock was as severe as in Stockton. (*Stockton Independent*.)

In a slough water was thrown into ebullition to a height of 2 feet for a few minutes. (*Stockton Gazette*.)

Berkeley. — The State Institution for the Deaf, Dumb, and Blind lost 11 chimneys and 2 gables, and rear walls were cracked in several places. (*Oakland News*, Oct. 21, 1868.)

Oakland. — Shock preceded by a rumbling sound. Pans of milk and tubs of water emptied almost in a moment; trees whipt about like straws; many houses twisted 5 or 6 inches out of square, particularly those on brick foundations. The crashing of falling brick at the Deaf, Dumb, and Blind Institute was heard a few blocks to the south before the shock was felt. Chimneys very generally down, particularly those on south and east sides; in some parts all chimneys thrown. Many chimneys twisted, if not thrown. Many brick buildings were shattered, and several wharves went down with loads of brick, coal, hay, etc. In Brooklyn, as in Oakland, many chimneys were broken off at the roofs. (*Alta California*, Oct. 22, 1868.)

The drawbridge of the San Francisco and Oakland Railway was thrown out of place about 8 inches. (*Centennial Book of Alameda County*, p. 266.)

Thruout the city chimneys and walls fell south. (*Oakland News*.)

Of two houses next each other the older one stood on posts 4 feet above the ground, while the other was supposed to be earthquake proof. The basement walls were solid and of good workmanship. The old house was badly shaken, but not injured; the earthquake-proof house had the basement walls cracked, all the ceilings thrown down, and the marble mantel in each of the rooms thrown upon the floor. (Geo. Davidson.)

Alameda. — Shock very severe. Scarcely a house escaped uninjured. (*Alta California*, Oct. 23, 1868.)

San Leandro. — The earthquake was much more severe than in Oakland or Alameda. Not a building escaped some injury. Chimneys fell north and south. The court-house was in ruins. A tank 10 feet wide and 6 feet deep was entirely emptied of water. The bed of San Leandro Creek, which had been dry for several months, became filled with a stream of water 6 feet wide and a foot deep. A team of mules descending a hill 9 miles east of Haywards, were thrown to their knees. A rumble preceded the shock. The rangers on the old Peralta rancho said the crack past through the foot-hills on to Oakland. (Various old residents.)

San Lorenzo. — The limbs of a sycamore tree, 24 feet high, struck the ground. (G. Hyde.)

Flat irons and a kettle were jerked off the stove southward. (Mrs. Adams.)

House and barn were both prostrated. (Mrs. E. H. Gansberger.)

A house was thrown off its foundations. Chimneys were thrown northward. (E. Llewellyn.)

Haywards. — The crack past diagonally up the Haywards Hill and crost 3 feet from the south corner of the old hotel; past just east of the Odd Fellows' Building, through the Castro lot, tearing off a corner of the adobe house which stood where the jail now is, on through Walpert's Hill toward Decoto. By the hotel the crack first opened 18 to 20 inches, but soon closed to 5 or 6. It was of unknown depth; several balls of twine, tied together, with an iron sinker, failed to find bottom. There was no water in the fissure, for the iron came up dry. From the corner of B and First Streets another crack past nearly eastward toward the hills, and faded out by the sulfur spring about 1.5 miles distant. (Mrs. Wm. Haywards.) In a general way, the crack from Haywards to beyond Decoto past from 100 to 300 feet above the base of the hills. Practically not a house was left on its foundations in Haywards. At one place south of town the fault showed a throw of some 3 feet. (W. H. Weilbye.)

"Since October 5, 1862, I have lived in Haywards, Alameda County, and I well remember the earthquake of October, 1868. Being lame and having used a cane from childhood, I had never walked without it until that morning. I was working in my shop at the time. On feeling the terrible shock, and on the impulse of the moment, I managed to

get out of the building and into the street, some 18 feet distant, but on recovering from my fright I found I had left my cane in the shop. I managed to get back into the building, got my cane, and started for my house only a few yards away. The house had been thrown from its foundations, the chimney had been torn from the roof, and the porch had been wrenched away. Dishes were broken and everything was in confusion. I discovered that most of the houses were in the same condition as my own — thrown from their foundations, with chimneys down, porches knocked sideways, etc. All the while the ground was shaking and continued to shake for days and even weeks; but each shock was lighter than the last. On a certain piece of ground near the Haywards Hotel there was a common board fence, the boards abutting on the post. After the quake the boards lapt one over the other about 5 inches, the ground seeming to have been prest together that much. On going down the county road toward Oakland, we came to Mr. A. L. Rockwood's house, which had been thrown from its foundation and one end thrown into the cellar. The house was badly wrecked. In the south part of the town there was a flour mill on a foundation about 4 feet high. This building was thrown to the ground and wrecked. On the ground which is now the plaza stood a new brick warehouse filled with grain from the season's crop. The building was completely torn to pieces; grain was spilt from the sacks, and everything was in a mess. The building was 300 feet long by about 60 feet wide. A wooden warehouse about the same size shared the same fate as the brick. On B Street the ground opened about 2 inches, and water and sand were forced from the opening. Some springs were closed, while others were opened or made to flow more freely. Many wells were affected in the same manner. Mr. Charles Herman, who was in the baking business, was driving back to Haywards after delivering bread. Looking up the road, he saw the ground coming toward him in waves, and when the motion struck his horse, she went down on her knees. Mr. Herman thought the world had come to an end. As he neared the San Lorenzo Creek, he noticed that the water had been thrown out of the bed of the creek on to the road.

"At San Leandro the earthquake destroyed the brick court-house, which was then located there. A Mr. Joslyn was killed in attempting to escape from the building. Many buildings were much damaged in that town as well as in Haywards. The earthquake was the direct cause of the death of 2 persons in Haywards." (George A. Goodell.)

The crack past thru a gravel quarry practically on the summit of the first range of hills. (O. Hill.)

The crack below Haywards Hotel was 12 inches wide. It ejected water and white sand. A fence which traversed a hill from north to south was crosst by the crack, and had the ends of the boards loosened from the posts. Gradually these boards lapt over one another, until within a couple of weeks they overlapt several inches, the progress of the overlapping being noted from time to time by a pencil mark. The "cap" board of the fence was also arched up in consequence of this movement. Large waves were set up in the soil. The house was moved southward, while a neighbor's was tipped northward. (D. S. Malley.)

The rumbling preceding the shock came very distinctly from the bay, and the plain in that direction rolled like huge waves of the sea coming toward Haywards. (F. Allen.)

The crack opened parallel to Castro Street, 35 to 50 feet below Haywards Hotel. The fence passing diagonally up the hill was shortened 6 inches. (P. McKeever.)

A stove in the house was thrown north. (J. Wolput.)

A crack 3 to 4 inches wide started from the Powell place and struck across toward the county bridge next to Nettleton's, passing west of it; crosst the creek, demolisht a fence completely, and past on toward the Strowbridge residence, where the house was badly shattered. (Mrs. Hamer.)

The shock was from southwest to northeast. The ground opened from 6 inches to 2 feet, and water with sand was ejected to a height of from 1 to 3 feet. North of the village a ridge of ground 3 feet wide was raised 2 feet. By the time the shock was over, nearly the whole place was in ruins. Near Hayward's Hotel the hill shifted a good deal, and a crack opened for several hundred feet. On the hills there were several new springs. In the first 12 hours after the main shock there were 36 after-shocks. Between Haywards and Mission San Jose there were numerous cracks, so that it was difficult to drive a stage between the two towns. (*Alta California*, Oct. 22-25, 1868.)

Mt. Eden. — All the shelving on south side of the 2 stores of the town was thrown down. (*Alta California*, Oct. 22, 1868.)

Alvarado. — Shocks were violent. The ground opened in several places and water issued. (*Alta California*, Oct. 22, 1868.)

Centerville. — A dwelling-house was partly destroyed and 2 stores were wrecked. Hotel settled 2 feet. (*Alta California*, Oct. 22, 1868.)

Roberts' Landing. — "Our house broke in three pieces, each part falling outward. A boiler of hot water was on the stove, and with the first deafening jolt, the hot water came my way, giving me a bath I have never forgotten. Horses fell to the ground and men clung to some quince trees near.

"Captain Petersen, of the steamer *San Lorenzo*, who is now deceased, was walking along the road to Roberts' Landing when he heard a great rumble off across the fields toward San Leandro. He looked quickly in that direction, and over a mile away could see the great wave rapidly approaching. He rushed to the side of the road and had caught hold of the fence by the time the shock broke. Near him on the road a 6-mule team was drawing a load of grain, and all the mules fell flat and could not regain their feet until the great jolt was over. During the 3 or 4 succeeding days there were 150 shocks; none, of course, with anywhere near the extent of the heavy one." (R. C. Vose.)

Decoto. — Opposite Decoto a crack appeared about one-third of the way up the slope. It opened 10 or 12 inches at the surface and faulted about as much on the plains side. The level lands waved like the ocean, and the waves seemed to approach from the south. (Mr. Decoto.)

Tyson Lagoon, south of Niles. — A tank swayed north, then south, and fell. The lagoon parted lengthwise down the middle and threw water and mud both ways. After the earthquake the lagoon was dry for 3 years. It has no outlet. Rumbblings preceded the main shock and many of the after-shocks. (Mrs. Wm. Tyson.)

A crack went thru the old Shinn place, crost the Centerville-Niles road about 0.6 mile southwest of the Southern Pacific Railway track, and past thru the Tyson Lagoon. (H. Tyson.)

Niles. — The water from the tank slopt nearly east. Rumbblings preceded the after-shocks. These were more severe than in April, 1906. (C. Overacher.)

A crack past thru the Shinn and Tyson places. (C. Bonner.)

Irvington. — Thru the north side of town a crack split the hillside, opening 7 or 8 inches and showing a fault of 8 or 10 inches. It crost the country road 500 feet north of the Southern Pacific Railway depot. Its trend was N. 45° to 50° W. From these low hills the crack seemed to pass over into the tule ponds north of town. The Tyson Lagoon dried up after the quake. The rumbling preceding the shock came from the north. (R. B. Crowell.)

The railroad tracks north of the station were badly twisted for several hundred yards. (M. Torrey.)

In one place the crack on the hillside divided, and formed a narrow island, 8 or 10 feet across, which dropt below the general level of the sod 8 or 10 inches. Springs were opened up on Mission Peak. (H. Crowell.) The crack which past thru the town con-

tinued southward down the hillside about 0.5 mile northeast of the railway track. It opened 5 to 8 inches, not faulting.

"I was then about 15 years of age. My home was near Irvington. When the shock came, I was alone in the house with my baby brother. My mother was in the milk house, about 10 steps from the kitchen door. She called to me to get the baby. Tho I was thrown the length of the dining-room, I managed to get the child over my arm, face down, and a pillow on top. Then, falling and crawling, I worked my way back to the open kitchen door. My mother was on the ground. Every time she tried to get up, she was thrown again, and the milk in the buckets was spilt over her. My two brothers, my step-father, and the hired man were also down and were trying to get to the house by crawling and falling. As I sat there, I could see the ground in waves like the ocean. After the main shock, I think we had 100 shocks during the first 24 hours. The ground opened; we traced a crack thru town, and the ground settled several inches in one place. Not a house was left with a chimney on it. Our safe broke thru the floor, and the piano was out in the room nearly to the opposite side." (J. McD. Preston.)

Mission San Jose. — "I was curled up in a big rocking-chair, reading, and my two sisters were outside playing, when suddenly there came a swaying of the house. This lasted only a short time; then the house began to shake in earnest. My sisters began to cry and scream. I jumped out of the chair to go to them, and ran from the room, bumping against both sides of two doors. I finally reached the porch and succeeded in catching hold of a post. I distinctly remember that the pump in the yard was pumping as if some one had hold of it; and small rocks on the hill in front of the house were rolling down into the creek. The milk pans had been resting on shelves of slats; some pans slipt entirely out, some only halfway. The milk and cream were on the floor. My brother was hauling a load of wheat to San Jose. When the earthquake was at its worst, he thought his team was choking down and jumped off his wagon to find he could hardly stand. I was told at the time that the water spurted up in the streets of San Jose, and out in the road between Milpitas and San Jose, to the height of several feet. The old Mission church, which was of adobe, was shaken down, as were several other buildings at the same place. On the mountain above the old Mission, just above a place called Peacock Springs, a great crack in the earth appeared, which lookt as if the lower part of the mountain had parted and slipt down. Many times I have crost the bridge which was built over the crack, and stopt and thrown rocks down to see if I could tell how deep it was." (Mrs. N. Ainsworth.)

Along the hills back of the town and southward, passing thru the present Sinclair and Stanford ranches, the crack opened. Generally it was 10 or 12 inches wide, and faulted some 18 inches on the valley side. (A. Kell.)

The shock was preceded by a rumble passing to the northwest. Adobe building not seriously injured. Crack at Irvington and on the side of Mission Peak confirmed. (J. Sunderer.)

Brick store was cracked. Confirms cracks at Irvington. (S. Ehrman.)

Chimneys fell north and south, as they did also on April 18, 1906. (S. Murphy.)

Warm Springs. — The crack past along the foot-hills at an elevation of 350 to 450 feet from Niles southward, back of Mission San Jose, disappearing near the county line. In some places the fissure showed a fault of 10 to 12 inches. (H. Curtner.)

The warehouse and wharf on the slough fell, also Dixon's house. Cracks in the vicinity of Milpitas flowed artesian water for 48 hours after the shock. (Mr. Durkee.)

Milpitas. — Along Coyote Creek the ground was cracked from Boot's ranch to the San Francisco Bay, the cracks being on the bay side and following the winding of the creek. As in 1906 much water was ejected from the cracks, and Coyote Creek rose. (W. Bellou.)

Calaveras Valley. — Only one or two chimneys were dislocated. (J. Patton.)

Santa Clara County. — Messrs. J. W. Hines and C. Valpey, and Miss Bennett, of San Jose; Mr. H. B. Valpey, of Santa Clara; Messrs. P. Anderson and C. B. Mendor and Mrs. W. Smith, of Berryessa, all of whom were intimately acquainted with this section of the country in 1868, report that there was no crack south of the county line.

Alcatraz Island. — A rumbling sound accompanied the shock, and the island vibrated with a jerking motion. (Dr. L. Hubbard, U. S. A., in *San Francisco Times*, Oct. 22, 1868.)

Colma. — "I was then 16 years of age and lived in San Mateo County, a mile or so south of the present town of Colma. With my father I was digging and sacking potatoes in a field. I was sewing up a sack, when my father said: 'Look at that mountain. What is the matter with it?' We felt no earthquake, but the mountain seemed to be bobbing up and down. A freight train was going north along the S. P. track. Shortly after we had observed the mountain apparently moving, the earthquake reached the railroad track and the freight train appeared to gyrate like a snake. The next instant we felt it. The shock was very severe, throwing us to the ground and knocking over sacks of potatoes. A band of loose horses, including a lot of young stock, in an adjoining field, ran around the field at great speed, utterly panic-stricken. The house we lived in was in a flat some 0.5 mile from where we were at work. When we reached it, we found that milk pans in the pantry had been entirely emptied of their contents. Some panes of glass were broken and some crockery and glassware were thrown down and destroyed; but the house, a light frame building, was not injured. There were 48 shocks between the first one and midnight that night.

"I do not now recall any serious damage done in San Mateo County. There were some landslides occasioned along precipitous hills and creek banks, but the buildings in that section were all frame, and none of them were destroyed to my knowledge." (J. A. Graves.)

San Mateo. — Vibrations from the north for 15 seconds. (*Alta California*.)

Redwood City. — The court-house was wrecked and other buildings were damaged. The shock seemed to come from the southeast and lasted 30 seconds. (*Redwood Gazette*, Oct. 24, 1868.)

Mountain View. — Severest earthquake yet felt. Far worse than that of 1865. Shock from northwest to southeast. (*Alta California*, Oct. 23, 1868.)

Santa Clara. — Severe shock. Motion northeast to southwest. No serious damage. (*Alta California*, Oct. 22, 1868.)

San Jose. — "The most terrible earth shock ever experienced in this section since the settlement of this country by Americans, occurred yesterday morning at 8 o'clock. A dense fog hung over the city at the time, when, with scarcely a premonitory tremor, the shock was upon us in all its force. Buildings and trees seemed to pitch about like ships in a storm at sea. Fire walls and chimneys were thrown down in all parts of the city. The heavy brick cornice of Murphy's building at the corner of Market and Eldorado Streets fell to the ground. The Presbyterian Church has sustained an immense damage. The brick turrets are all down, and large portions of the steeple were precipitated thru the roof to the floor, crushing the organ and causing great damage to the gallery and fixtures below. The walls of the steeple are almost a total wreck and will have to be taken down. \$5,000 would not make good the damage done to the church. The large water-tank on the roof of Moody's flour mill fell thru the roof, carrying destruction in its course. Their wooden store-house, 100 feet in length, filled with grain, is a total wreck and the grain badly mixed. Two huge chimneys of the San Jose Institute were thrown down, one of them crushing thru into the rooms below. A portion of the rear wall of Welch's livery stable fell. Otter's unfinished block at the corner of First and St. John Streets, sustained a very serious damage. There is not a brick building

in the city that is not more or less injured. Brick walls are everywhere wrenched and cracked and many of them are ready to fall. Another such shock would precipitate many of our brick buildings to the ground. The brick cornice of the Masonic Hall Building will have to be taken down, and the entire building, in its present condition, is decidedly unsafe for occupancy. A large quantity of crockery and glassware was broken. The destruction of plate-glass windows is very great, and much havoc is done to plastering generally. The new court-house stood the shock admirably. Some little crumbling of plaster decoration is all the damage it sustained. The lesson of the earth shock is: Erect no more high church steeples, and build no more brick buildings above 2 stories in height, and those only in the most substantial manner. A second but much lighter shock was experienced at about 10^h 30^m of the same day, and shortly thereafter a third shock of like character." (*San Jose Mercury*, Oct. 22, 1868.)

Where the Milpitas road crosses Coyote River, the banks were shaken together and the river-bed filled up. (*San Jose Argus*, Oct. 24, 1868.)

Old Gilroy. — The building shook and rocked till the occupants became seasick. The oscillation seemed to be southwest and northeast, and lasted about 30 seconds. No damage was done beyond some broken bottles in the drug store. (*Gilroy Advocate*, Oct. 24, 1868.)

Rumble preceding the shock came from the north. Chimneys fell north and south. It was fully as heavy as the shock of 1906, but not so long. The old adobe buildings were much damaged. (W. D. Dexter.)

The shock was not so severe as in 1906. (Messrs. Rice, C. Wantz, Bryant, Gilman.)

Pacheco. — Every brick house in town was ruined. (*Alta California*, Oct. 22, 1868.)

San Juan. — The shock was the heaviest since 1865. Lasted 30 seconds. (*Alta California*, Oct. 22, 1868.) No chimneys fell; 2 brick walls were cracked. (C. Bigley.)

Santa Cruz. — Severe shock from east to west, preceded by rumbling noise. Lasted 15 seconds. Several brick buildings badly cracked. (*Alta California*, Oct. 22, 1868.) Second only to the earthquake of 1865. Vibration from northeast to southwest for 30 to 40 seconds.

At Watsonville chimneys and plastering suffered but little. At Eagle Glen a slide 50 feet wide carried rocks and trees 1,000 feet. In Soquel a few chimneys were dislocated.

Half Moon Bay to Pescadero. — Chimneys down or twisted, along the coast. (T. G. Phelps, Holden's report.)

Near Pescadero limbs fell from the redwoods and large pieces of rock rolled down the mountains. (*Grass Valley Union*, Oct. 29, 1868.)

Monterey. — A smart little earthquake, traveling from north to south. No particular damage. (*Monterey Gazette*.)

Downieville. — A slight earthquake was felt. (*Mountain Messenger*, Oct. 24, 1868.)

Grass Valley. — Lamps vibrated. Vibrations from southwest to northeast. (*Alta California*, Oct. 22-24, 1868.)

Nevada City. — Three distinct shocks felt. Also felt at You Bet. (*Nevada Transcript*.)

Placerville. — Shock plainly felt. (*Mountain Democrat*, Oct. 24, 1868.)

Amador County. — The earthquake was distinctly felt at Pine Grove and Volcano. (*Alta California*, Oct. 25, 1868.)

Jackson. — Earthquake perceptible to a number of people. (*Amador Dispatch*, Oct. 24, 1868.)

Folsom. — A slight shock. Clocks stopt. (*Folsom Telegraph*, Oct. 24, 1868.)

Sonora. — A slight shock. (*Alta California*, Oct. 22, 1868.)

Tuolumne. — Shock lasted 10 to 15 seconds. Severe. (*Tuolumne City News*, Oct. 23, 1868.)

Snelling. — Hard shock. No damage. (*Merced Herald*, Oct. 24, 1868.)

Visalia. — Shock felt by few persons. (*The Delta*, Oct. 28, 1868.)

Nevada. — At Gold Hill and Carson, shock perceptible to people awake, and a few people awakened. (*Territorial Enterprise*, Oct. 22, 1868.)

The shock was apparently not felt in Ukiah, Yreka, San Luis Obispo, Los Angeles, Reno, Virginia City, Alpine County, Yuba County, Trinity County, or Oregon.

SUMMARY.

A review of the facts above presented regarding the earthquake of 1868 makes the following summary statement possible:

1. The earthquake of 1868, like that of 1906, was due to an earth-movement on a rupture plane or shear zone which was manifest at the surface as a fault-trace.
2. The fault on which the movement took place was quite distinct from the San Andreas fault.
3. It parallels the latter at a distance of about 18.5 miles to the northeast.
4. Like the San Andreas fault, it is coincident with an old diastrophic line upon which similar movements have been recurrent in time past.
5. The old diastrophic line is marked by a degraded fault-scarp, which bounds the valley of San Francisco Bay and Santa Clara Valley on the northeast.
6. Along this line there are certain geomorphic features analogous to those which characterize the San Andreas Rift.
7. The fault-trace of the fault of 1868 was much shorter than that of 1906, having a known length of only 20 miles.
8. The amount of horizontal movement, if any, was much less than on the San Andreas fault in 1906, and its direction is unknown.
9. The vertical movement appears from the accounts given to have been small also, and to have been manifest as a downthrow on the southwest or bay side, altho this is not satisfactorily established.
10. The fault-trace was characterized for the most part by a crack which in places, particularly on the lower ground, was superficially gaping. Associated with this main crack there were auxiliary branching cracks; and on the alluvial bottom-lands about San Francisco Bay there were numerous secondary cracks which were usually not discriminated by the observers of that day from the fault-trace.
11. In harmony with the shortness of the fault-trace and the small movement apparent along it, the area of destructive effect was much smaller than in the case of the earthquake of 1906. This was true also of the entire area embraced by the isoseismal II R. F. While the data are insufficient for plotting the isoseismals satisfactorily, it is nevertheless clear that these curves plotted as ellipses on the map of California would have had much shorter major axes than in the case of the isoseismals for the earthquake of 1906; while the minor axes in a northeast-southwest direction would not differ greatly for the two earthquakes. We have no authentic reports of the earthquake north of Chico nor south of Monterey, altho perceptible tremors probably did extend further south. On the other hand, in a direction normal to the fault-trace the earth-wave made itself felt as far as the State of Nevada.
12. The intensity was X in the vicinity of the fault-trace at Haywards.
13. In San Francisco the chief damage caused by the earthquake was, as in 1906, on the made land and along the margin of the old shore and marsh border. But little damage was sustained by structures on the rocky slopes.
14. The foot of Market Street, San Francisco, is about midway between the San Andreas Rift and the fault-scarp upon which movement occurred in 1868. The city

has, therefore, to reckon with the latter as well as the former in its future career, and consequently should be doubly prudent in the location and structure of its important buildings.

15. The cities on the east side of San Francisco Bay are less concerned with the San Andreas Rift, but are more immediately affected by the proximity of the diastrophic line marked by the front of the range of the Berkeley Hills.

16. The interval between the disastrous movement of 1857 on the San Andreas Rift and the movement on the Haywards fault in 1868 was 11 years.

THE EARTHQUAKE OF 1865.

About 12^h 45^m P. M., on October 8, 1865, a moderately severe earthquake shook middle California. Most of our information regarding it is assembled in Holden's Catalogue of Earthquakes. In the *Sacramento Daily Union* of that date it is described as the most violent ever experienced there. After several vibrations a second or two intervened, and the shaking was then repeated more violently than at first. The vibrations seemed to be east and west, but a few people thought they were from southwest to northeast. Clocks stopt, and there was a general feeling of dizziness and nausea. The same paper states that at Stockton the shock was heavy and seemed to pass from north to south, but that no damage was done. At Petaluma there were two severe shocks in quick succession, vibrating from northwest to southeast. The shock was the heaviest experienced up to that time. All brick buildings were more or less injured. The first shock was from the northwest to the southeast, followed by a general shaking or rolling, closing with a jerk. At San Jose the shock was very severe. Brick walls fell and the convent bell tolled. At New Almaden a large brick store-house on the hill was nearly demolisht. Several houses in the village were thrown down. The earth opened and closed again. Chimneys in different parts of the county were thrown down. (*San Francisco Bulletin*, Oct. 12, 1865.)

At Watsonville there was a heavy shock. The earth opened in several places (secondary cracks), throwing up water. At Santa Cruz the shock was apparently heavier than elsewhere. Every brick building was reported ruined. The motion was apparently east and west. The lowlands along the river opened and spouted water like geysers. Some wells went dry or were filled with sand. The tide rose very high at the time of the shock and fell very low immediately afterwards. (*Bulletin*, Oct. 9, 1865.)

"Monterey escaped unharmed." (*Sacramento Daily Union*, Oct. 9, 1865.)

After shocks were reported at San Jose, Santa Clara, and Santa Cruz.

There is no record of the shock having been felt at Marysville, Yreka, Eureka, or in Alpine County; the *Mountain Messenger* of October 14, 1865, states that it was not felt at Visalia nor in Los Angeles. The *Bulletin* of October 17, 1865, states that it was not felt in Santa Barbara.

In San Francisco, according to the *Bulletin* of the date of the earthquake, there was a violent shock lasting about 5 seconds, followed almost instantly by another much heavier shock, which continued for 10 seconds or more. Vibrations appeared to be nearly east and west, but some experienced observers said that the movement was in the same direction as previous shocks — nearly northeast and southwest. The commencement of the shock was accompanied by a rumbling sound. During the following evening there were two or three slight after-shocks. The effects of the earthquake were visible in every street. No buildings were entirely demolisht, but the damage aggregated many thousands of dollars. The most important damage to buildings occurred at the following localities:

Corner Mission and Third Streets. Upper half of front of 4-story brick building fell; poorly constructed.

Northeast corner Battery and Washington Streets.

Old Merchants' Exchange ruined.

Beale Street, near Market.

Kearney Street, near Sutter.

Jackson Street and Stout Alley.

Mission and Fremont Streets.

Battery and Union Streets.

Corner Kearney and Washington Streets. City Hall had front wall badly cracked and entire building rendered unsafe.

Washington Street, near Sansome.

Market Street, near Sansome.

Pine Street and Front Street.

Market and Pine Streets.

Sacramento and Battery Streets.

Sacramento and Webb Streets.

On the marshy lands in the vicinity of Howard and Seventh Streets the ground was heaved in some places and sank in others. Lamp-posts were thrown out of perpendicular, gas-pipes were broken, etc.

It appears probable from these scant records that the seat of the earthquake of 1865 was somewhere in the Santa Cruz Mountains, between San Jose and Santa Cruz. If this conclusion be accepted, it seems further probable, in the light of recent events, that it was due to a minor movement along the San Andreas Rift. It was probably a somewhat less severe earthquake than that of 1868. The earth movement which gave rise to the shock extended neither so far south as in 1857 nor so far north as in 1906, but appears to have pertained to that portion of the Rift affected in 1906 rather than to that affected in 1857.

The only other earthquake which can definitely be referred to a movement along the San Andreas Rift was that of April 24, 1890, which, according to Messrs. F. Abby and Charles Bigley, of San Juan, opened a fissure at that place on the line of the Rift. The railway bridge at Chittenden was displaced, as it was in 1906.

THE EARTHQUAKE OF 1857.

Information regarding the earthquake of 1857 is scant and generally unsatisfactory as to details. California at that date was very sparsely populated, particularly in the southern Coast Ranges, where the seat of the disturbance was. The only records that have come down to us are those of Trask, in the Proceedings of the California Academy of Sciences, Vol. I, 1873; a note by J.S. Hittel in his "Resources of California," 1863, p. 42, and some notes in Holden's Catalogue of Earthquakes. These brief notes are supplemented by the statements of a few old residents who recall the event, some of whom were in the zone of acute disturbance at the time. The data, while insufficient for a satisfactory account of the earthquake, warrant the statement that it was due to a displacement or fault in the San Andreas Rift, along its extent from Cholame Valley to the San Bernardino Valley, a distance of about 225 miles.

According to Dr. Fairbanks, who has recently been over the course of the Rift in the southern Coast Ranges, the residents along that line have either very vivid recollection or very strong tradition regarding the rupturing of the ground at the time of the earthquake; and Dr. Fairbanks' field observations confirm the probable truth of their statements. It appears to have been generally recognized by people familiar with the southern Coast Ranges that the shock was due to or associated with the rupture of the ground, and the line of rupture is commonly referred to by the country people as the "earthquake crack." This crack, as opened in 1857, with differential displacement of unknown extent and direction, is still pointed out as a remarkable phenomenon from Cholame Valley southeastward along the northeast side of the Carissa Plain, through the Tejon Pass, thence along the southwest side of the Mojave Desert, past Lake Elizabeth and Palmdale, to the Cajon Pass and thence to the south side of the San Bernardino Range. The shock was felt from Fort Yuma to Sacramento, and the total area sensibly affected was probably not much less than in the earthquake of 1906. It was severe both at Los Angeles and San Francisco. At Los Angeles shocks continued at intervals during the

day. Mr. H. D. Barrows, who was in that city on the day of the earthquake, in a letter dated August 5, 1906, communicates the following information as to his experiences:

The great earthquake of January 9, 1857, in southern California, opened the ground for nearly 40 miles in a straight line near Elizabeth Lake. I had a brief account of it in the *San Francisco Bulletin* about February 1, 1857 — my letter (signed "Observador") being dated January 28, 1857.

Only one life was lost by that great convulsion of nature, a woman being killed at Fort Tejon by the falling of adobe walls; and, considering the colossal disturbance, very little damage was done to buildings here in Los Angeles. This is probably accounted for by the fact that our buildings were of only one story, with walls 2.5 and 3 feet thick. At the time of the great upheaval, I was in the yard at the south side of the adobe house of William Wolfskill, the pioneer, near the present site of the Arcade Depot in Los Angeles. I first stumbled toward the west, and was almost thrown down; then, after a brief period, I commenced to stumble in the opposite direction. Other persons near me stumbled in similar fashion. The long wide corridor on the south side of the Wolfskill house was hung with grapes, and I noticed that they swung back and forth clear up to the rafters. Water in tanks was thrown out in numerous instances, clocks were stopt, etc. The movement seemed to be comparatively slow, giving things time to recover after moving in one direction. If the motion had been short and sudden, the damage would have been appalling.¹

All the houses in Santa Barbara were damaged by the shock of 11^h 20^m P. M., January 8. (Perry, Holden's Catalogue.)

At Visalia it was difficult to stand erect; treetops waved several feet to and fro; it was equally severe at places within 50 miles north and south. There were several shocks felt at Stockton and Benson's Ferry, and the principal one was very severe at Sacramento, Los Angeles, and Monterey. (*San Francisco Bulletin*, Jan. 9, 1857.)

At San Francisco the main shock was preceded by 4 slight shocks at 11^h 20^m P. M., January 8; 11^h 33^m, 4^h 15^m, and 7^h A. M., January 9. The main shock stopt a jeweler's clock at 8^h 13^m 30^s A. M. Prof. George Davidson, who was in the city at the time, says the shock was sudden and sharp, preceded by no noise. He was lying north and south, and felt the movement in that direction. A friend who was lying east and west was thrown out of bed.

Professor Davidson also contributes the following:

The wholesale grocery store of Goodwin Brothers faced east on Battery or Front Street, with its length of about 100 feet on Commercial Street. It was a 1-story brick structure about 15 feet high, with a flat metallic roof and a fire-wall of 3 or 4 feet above and around the roof. There were no windows nor doors on Commercial Street. The fire wall along Commercial Street was thrown bodily from the main structure into the street. The inner edge of the bricks was a straight line, at a measured distance of 6 feet from the base of the wall, while the general mass was scattered across Commercial Street. In the hardware establishment of Philip T. Southworth, along the west side of the east wall, there was a line of nail kegs, every one exactly 12 inches from the baseboard. Before the shock they had been placed close to the baseboard. These two conditions would indicate a movement of the earth from the northward and westward — roughly, from the north-northwestward. I do not remember damages to other buildings, but am satisfied there were no serious results to property. Among minor details were the effects of the shock upon one of the piled wharves, where a lot of bar-buoys had been left. They had been rolled about in every direction.

The following note on some of the effects of the shock in various parts of the state is extracted from Hittel's "Resources of California," 1863, p. 42:

The waters of the Mokulumne River were thrown upon the bank, almost leaving the bed bare in one place. The current of the Kern River was turned up stream, and the waters ran 4 feet deep over the bank. The water of Lake Tulare was thrown upon its shores, and the Los Angeles River was flung out of its bed. In Santa Clara Valley artesian wells were much

¹ Los Angeles is about 40 miles from the line of the Rift. A. C. L.

affected; some ceased to run, and others had an increased supply of water. Near San Fernando a large stream of water was found running from the mountains, where there had been none before. In San Diego and at San Fernando several houses were thrown down, and at San Buenaventura the roof of the Mission Church fell in. Several new springs were formed near Santa Barbara. In the San Gabriel Valley the earth opened in a gap several miles long, and in one place the river deserted its ancient bed and followed this new opening. In the valley of the Santa Clara River there were large cracks in the earth. A large fissure was made in the western part of the town of San Bernardino. At Fort Tejon the shock threw down nearly all buildings, snap off large trees close to the ground, and overthrew others, tearing them up by the roots. It also tore the earth apart in a fissure 20 feet wide and 40 miles long, the sides of which vent then came together with so much violence that the earth was forced up in a ridge 10 feet wide and several feet high. At Reed's ranch, not far from Fort Tejon, a house was thrown down and a woman in it was killed.

The most interesting fact connected with the earthquake of 1857 is that it was due to an earth movement on the same diastrophic line as that on which faulting occurred on April 18, 1906. The movement in 1857 was, practically speaking, along the southern half of the known extent of the San Andreas Rift, while that of 1906 was along the northern half.